The profile line as an aid in critically evaluating facial esthetics

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ORTHODONTISTS long have recognized that occlusion and facial beauty are so interdependent that they must be simultaneous and equal goals of treatment.

Tweed[26] gave special attention to esthetics, even in his earliest work concerning the position and inclination of the mandibular incisors in their relation to basal bone.

"In my opinion," he said, "a thorough concept of the normal growth pattern of the child's face or any face is as important to orthodontists, if not more so, as complete mastery of the science of occlusion."

Tweed suggested that, to achieve this goal, the orthodontist should use the diagnostic triangle in treatment planning and prognosis, and he emphasized the importance of the Frankfort-mandibular incisor angle. He cautioned that this alone was not enough, however; once its requirements were fulfilled, the eye of the orthodontist must be the deciding factor in determining whether the desired facial harmony had been achieved.

The practiced eye of the veteran orthodontist can see progress toward his esthetic goal, just as he recognizes occlusal improvement, but the less experienced clinician is not always sure. This study seeks to develop a more specific guide to help young orthodontists achieve the maximum facial harmony that is always the purpose of orthodontics.

REVIEW OF THE LITERATURE

Edward H. Angle,[2] one of the first to write about facial harmony, emphasized the importance of soft tissue; he considered the mouth a most potent factor in making or marring the character of the face, with the form and beauty of the mouth itself depending on the occlusal relation of the teeth. His chief concern

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was finding or establishing a harmonious relationship between the mouth and other features.

Tweed[26] said that normal faces, with few exceptions, had either normal occlusion or Class I malocclusion. In all cases the mandibular incisors were on basal bone. It seemed evident to him that there was a definite correlation between balanced facial lines and the position of the mandibular incisors in relation to basal bone.

He said that a concept of the normal is indispensable to the orthodontist; without it he does not know where or when to begin or end his treatment. He defined normal as "that balance and harmony of proportions considered by the majority of us as most pleasing in the human face." He found that in his nonorthodontic normal samples there was a corresponding compensation by the lower incisors with steepening Frankfort-mandibular angles to maintain good facial esthetics.

Downs[9] reported a definite facial pattern for persons with excellent occlusion. He found notable deviations on both sides of the mean facial pattern and said that these are the variations with which one must reckon when appraising balance and harmony of the face.

Tweed[29] said that the world should be a beautiful place for a child to live. If the child is handicapped by a facial deformity that is marring his happiness, we should make every effort to restore that happiness. Hiding behind the word *type* because it is the easiest way out or assuming that because a face pattern has serious abnormal deviations there is no use trying to help the patient is not courageous. We must accept the fact that normal occlusion, perfection of balance, and harmony of facial lines are impossible in such cases, but we must also strive for the most nearly normal face that conditions will allow.

Stoner and Lindquist[23] found that the soft-tissue changes which occurred during treatment were (1) a downward movement of the chin pad to about the same degree as the hard tissue and (2) a downward movement of the upper lip in the majority of cases.

The soft-tissue improvements were produced by four principal changes: (1) a reduction in the prominence of the lips; (2) a reduction of the curl in the lower lip; (3) vertical opening at the chin; and (4) some forward positioning of the chin.

Stoner and Lindquist said that the lower incisors have a definite relationship to facial esthetics. This relationship may be indirect, but it is important.

Downs[10] said that while individuals vary greatly in facial type and pattern, those with optimum oral health, functional balance, and esthetics have certain common profile characteristics.

Holdaway[11] believes that a forward positioning of point PO, or of the chin itself where very vigorous Class II elastic pull has characterized the treatment, results in a facial change that is most gratifying. His study also indicated that a recontouring of point B by lingual movement of the lower incisor increased the effective bony chin and was accompanied by improvement in facial balance.

He found a significant relationship between the lower incisor measured to the line NB and pogonion measured to line NB. He said that facial contour is

most ideal when these two measurements are equal. His work, using the line NB extended downward, gave the profession an excellent assessment of the bony chin.

Riedel[18] stated that the soft-tissue profile is closely related to the skeletal and dental structures that comprise the bony profile.

Burstone[7] found that the lower face not only plays a part in digestion, speech, and respiration but also influences to a large extent the social acceptance and psychological well-being of the individual. Because soft tissue may vary in thickness, length, and postural tone in different persons, it is necessary to study directly the integumental contour of the face in considering facial beauty and harmony.

Advertising media have presented to the public faces that are generally thought of as good-looking or beautiful. This impact has been so great that many, instead of developing their own concepts of facial beauty and harmony, have accepted this "Hollywood standard."

Alessandra[1] and Barnett[3] found the soft-tissue measurements of the upper lip and sulcus, lower sulcus, and chin integuments to be significantly thicker in males than in females, and the esthetic plane was approached more closely by the lips of males than of females.

Moore[14] questioned the concept of the "constancy of the facial growth pattern" when applied to the individual. He said that variation, not constancy, is the rule.

Horizontal growth of the face is not necessarily more desirable than vertical growth. The difference between favorable and unfavorable growth may best be explained in terms of individual bone structure, bone interrelationship, and differential growth rates.

Orthodontic therapy will have a favorable influence upon the growth of a retrognathic facial profile, provided there is genetic potential for harmonious development.

Neger[15] indicated that a proportionate change or improvement in the soft-tissue profile does not necessarily accompany extensive dentition changes; hence, we cannot rely entirely on a dentoskeletal analysis for accurate information on the soft-tissue profile changes which have occurred during orthodontic treatment.

Subtelny,[24] reporting on a longitudinal study, stated that the bony facial profile tends to become less convex with age. The soft-tissue profile (including the external nose) increases in convexity with progression in growth. The soft-tissue profile, excluding the nose from profile analysis, shows a tendency to remain relatively stable in its degree of convexity. The soft-tissue changes are not analogous to those of the skeletal profile. He also found that the antero-posterior posture of the lips is closely related to the teeth and alveolor processes, and that lip posture is closely related to underlying structures.

Subtelny[25] further said that it does not seem possible to devise a prescription for differentiating a desirable from an undesirable soft-tissue facial profile.

The vermilion aspect of the lips tends to maintain a close postural relationship to their supporting tissues, and there is a strong interrelationship between the lips and the dental structures. The soft-tissue changes that we can anticipate

during treatment center around the lips, primarily in the vermilion area.

Wylie,[31] in discussing the characteristics of a good face and what made one sort of face better than others, expressed his belief that all preferences are irrational and that we cannot say that there is but one desirable profile for a face.

In 1959 Wylie[32] stated that the orthodontist should have a number of objectives: (1) establishment of the best possible functioning unit, considering not merely the teeth but also supporting tissues, muscles, and structures of the joint; (2) establishment of the best possible outlook for health and longevity of these tissues; and (3) attainment of the best possible esthetic results, dental and facial, judged not only in repose but in animation as well.

Burstone[8] found that in certain horizontal values the upper lip is an average of 3 to 4 mm. greater in males than in females. The labiomandibular contour remains fairly constant, and the maxillomandibular contour (a measurement of facial convexity below the nose) demonstrates no significant difference. This suggests no marked flattening of the lower face in the postadolescent period. Burstone believes that an awareness of variation in the soft tissue should be an integral part of any orthodontic case analysis.

Ricketts[16, 17] found that lip convexity decreases consistently from the deciduous dentition age to the age of the full adult dentition. The lips are progressively more retracted. When facial disproportion and ugliness prevail, it is important to recognize facial form as an orthodontic problem.

The upper lip will thicken slightly following retraction of the upper incisors, depending on the strain of the lip in the beginning. There will be 1 mm. of thickening of the upper lip for each 3 mm. of retraction of the tip of the upper incisors.

The lower lip does not thicken but curls backward as a result of upper anterior retraction. There is an increase of soft tissue on the chin because of loss of lip strain and loss of chin elevation by the mentalis muscle. Treatment allows the ball of soft tissue to be lowered to its proper position.

Salzmann[19] says that the three components necessary in a cephalometric analysis are (1) skeletal analysis, (2) profile analysis, and (3) denture analysis.

The profile analysis is primarily an appraisal of soft-tissue adaptation to the bony skeleton. However, it was recognized that certain skeletal angular criteria, amount of tonicity of the soft tissue, and facial muscular posture can influence the appraisal of the profile. As yet there is no common agreement on factors to be considered and the relative weight to be given each.

Baum[4] believes that girls complete most of their developmental growth changes by the end of orthodontic treatment, whereas boys continue to change following treatment.

Bloom[5] says that there is a definite relationship between the dentoskeletal framework and the soft-tissue profile around the mouth. The maxillary incisor movements cause changes in the superior sulcus, the upper lip, and the lower lip. As the mandibular incisors change, so do the inferior sulcus and the lower lip. Knowing of these changes, it is possible to predict the perioral soft-tissue changes in relation to anterior tooth movement.

METHODS AND MATERIALS

Materials for this study came from three sources. Forty cephalometric roentgenograms were obtained from more than 100 nonorthodontic normal faces collected by Tweed as representative of his concept of "nonorthodontic normals."

Forty cephalometric roentgenograms taken at the completion of treatment were obtained from Tweed's files. These were selected by Tweed as representative of his concept of "orthodontic normals."

Forty cephalometric roentgenograms taken at the completion of treatment were obtained from my own files. These records were selected from more than 400 representing my concept of "orthodontic normals," based on facial esthetics and judged at the end of treatment.

All of these records were lateral cephalometric roentgenograms taken in a Margolis cephalostat, with the teeth in occlusion. The 120 roentgenograms were traced by standardized tracing procedures. In Fig. 1 a typical tracing of a cephalometric roentgenogram shows the landmarks used in this study.

The tracings included the outline of the soft-tissue profile as well as the osseous structures. The chin, the lower and upper lips, the nose, and the outline of the soft tissue covering the frontal bone in the midsagittal plane were traced from each head plate. In addition, the conventional osseous landmarks of the cranium and the face, as well as the maxillary and mandibular central incisors and the first permanent molars also were traced.

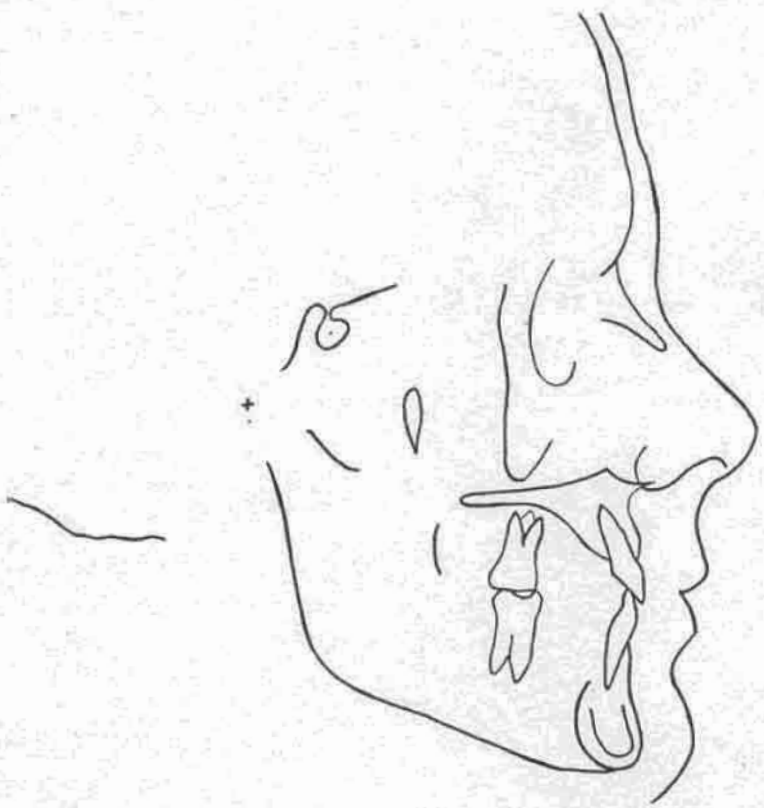

Fig. 1. A typical tracing of a cephalometric roentgenogram showing the landmarks traced in this study.

Using cephalometric porion and the inferior border of the orbit, Frankfort plane was established and used as a plane of reference. Another plane used was the mandibular plane; this was established by using the symphysis anteriorly and the lower border of the mandible at the gonial angle posteriorly. The mandibular plane was extended posteriorly to the Frankfort plane. Also used was the incisor plane, established by a line through the long axis of the mandibular central incisor, downward to the mandibular plane, and upward to the Frankfort plane.

These planes formed the Tweed diagnostic triangle. The angular readings FMA, IMPA, and FMIA were recorded.

The line NB was drawn from nasion through point B and extended inferiorly through the mandible to show the bony chin. The line NA was drawn from nasion through point A, and the angle ANB was measured.

A line was drawn tangent to the soft-tissue pogonion and to the most procumbent lip—lower or upper lip, whichever protruded the most anteriorly—and extended superiorly until it intercepted the Frankfort plane. This line was designated the profile line. The techniques of measurement and data classification will be described preceding the report of specific findings.

DATA AND OBSERVATIONS

The profile line. In the interest of evaluation and communication, a line of reference was needed. This was established by drawing a line tangent to the soft-tissue chin and to the most anterior point of either the lower or upper lip, whichever was most protruding, and extending it upward to Frankfort plane. This is a modification of the H line used by Holdaway,[13] which is tangent to the chin and the upper lip and extends upward to intercept an extension of SN.

The profile line (Fig. 2) is thus a reference to the position of the areas of the face over which the orthodontist has influence through tooth movements, namely, the region of the mouth. By using the most anterior point on the upper or lower lip, the line expresses the amount of lip protrusion.

Certain measurements were needed to describe and evaluate the profile line properly. One was a millimeter measurement of the total chin. This included the bony chin lying anterior to the line NB and measured to PO and the integumental overlay at the same point (Fig. 3).

In considering the chin in its relation to the face, it is important that the total chin be expressed. The osseous chin and its soft-tissue overlay vary greatly in individuals. It is not unusual to measure 2 mm. of bony chin and 14 mm. of integumental overlay; nor is it unusual to measure 6 mm. of bony chin and 10 mm. of soft-tissue overlay. To illustrate the individual variation, Table I shows the measurements of ten good faces used in this study.

The entire study showed this same variation in bony and integumental chin measurements. Some investigators have placed great significance on the bony chin, but I have found the over-all evaluation of the total chin to be more important in a study of facial esthetics.

Another measurement used in this study was a millimeter measurement of the horizontal thickness of the upper lip. This measurement, recorded from

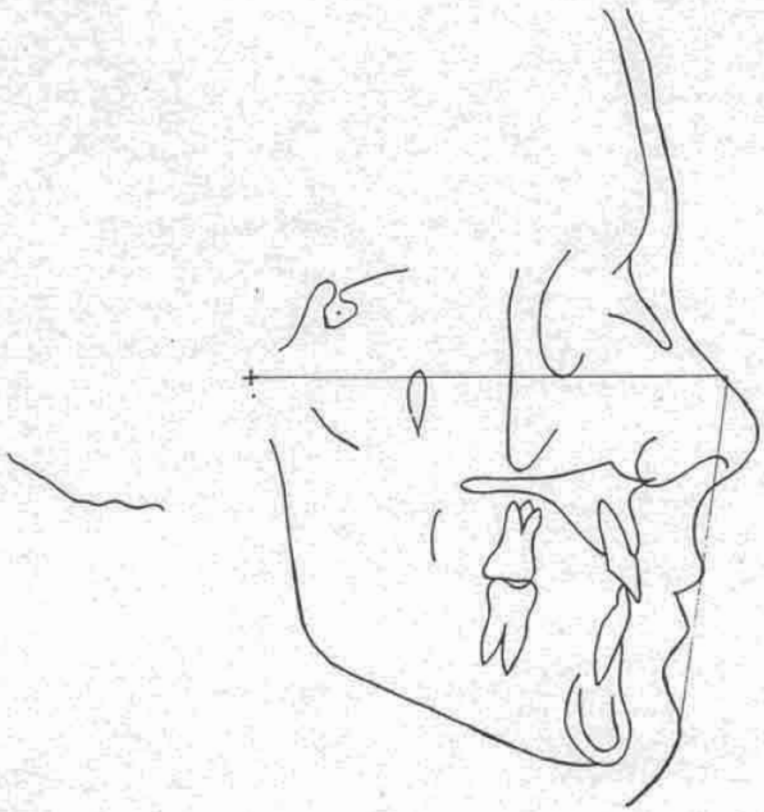

Fig. 2. The profile line.

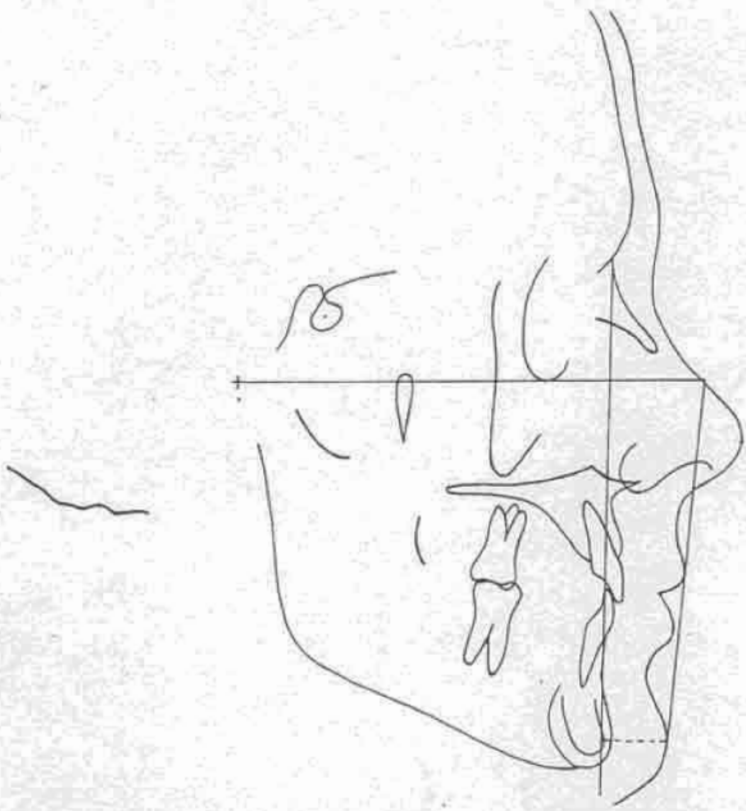

Fig. 3. Measurement used for total chin thickness.

Table I

Bony chin (mm.)	*Integumental chin (mm.)*	*Total chin (mm.)*
5	11	16
3	13	16
4	12	16
3	14	17
6	10	16
1	14.5	15.5
3	11	14
10	10	20
6	11	17
3	12	15

Table II. *Nonorthodontic normals*

Value	*Mean*	*Range*
FMA (degrees)	24.37	14 to 34.5
IMPA (degrees)	86.81	79 to 96
FMIA (degrees)	68.82	62.5 to 80
ANB (degrees)	1.97	−2 to 5
Z angle (degrees)	81.4	71 to 89
Total chin (mm.)	16.07	12 to 20
Upper lip (mm.)	13.74	9 to 18

prosthion to the most anterior point on the vermilion border of the upper lip, is depicted in Fig. 4.

An angular measurement used was the inferior angle formed by the intersection of Frankfort and the profile line. For simplicity, this angle was identified as the Z angle (Fig. 5).

The angles of the diagnostic triangle as well as the ANB angle were studied to determine whether a correlation existed between the various hard- and soft-tissue measurements. Fig. 6 shows a tracing with all planes and angles used in this study.

Forty nonorthodontic normals were selected by Tweed from a larger group of more than 100 samples (Table II).

In the nonorthodontic normals the average angular measurements of the diagnostic triangle were essentially the same as Tweed found in the larger sample; the range also was comparable. The ANB angle averaged 1.97 degrees, very close to the accepted normal difference of 2 degrees.

These figures indicate that the osseous dental base and the dental units were in normal relationship. The samples originally had been selected entirely on the basis of satisfactory facial esthetics. The measurements introduced in this study to further define facial esthetics showed an average Z angle of 81.4 degrees, with a rather wide range of 71 to 89 degrees. The group had an average total chin thickness of 16.07 mm. and an average upper lip thickness of 13.74 mm. Although

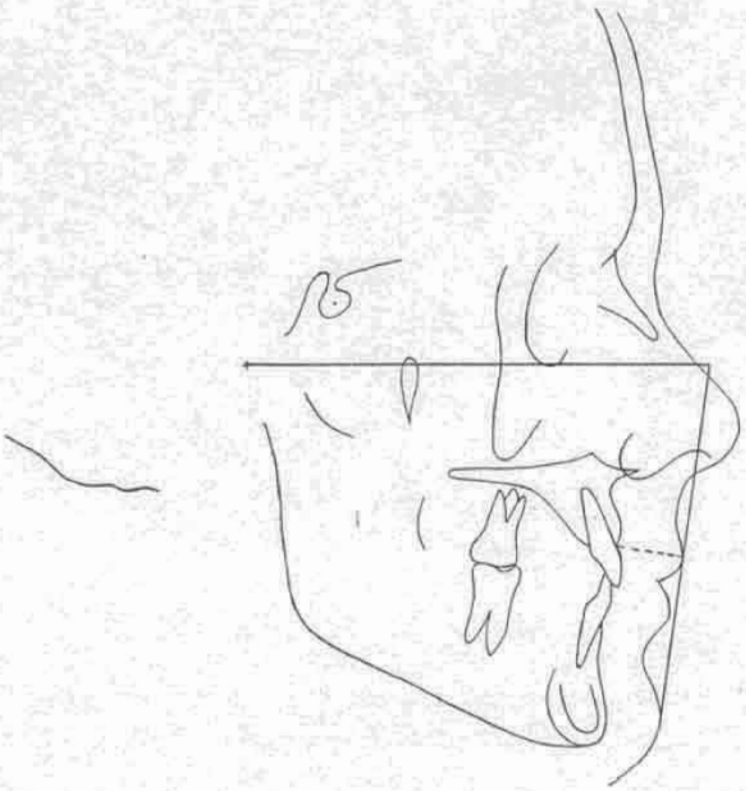

Fig. 4. Measurement used for upper lip thickness.

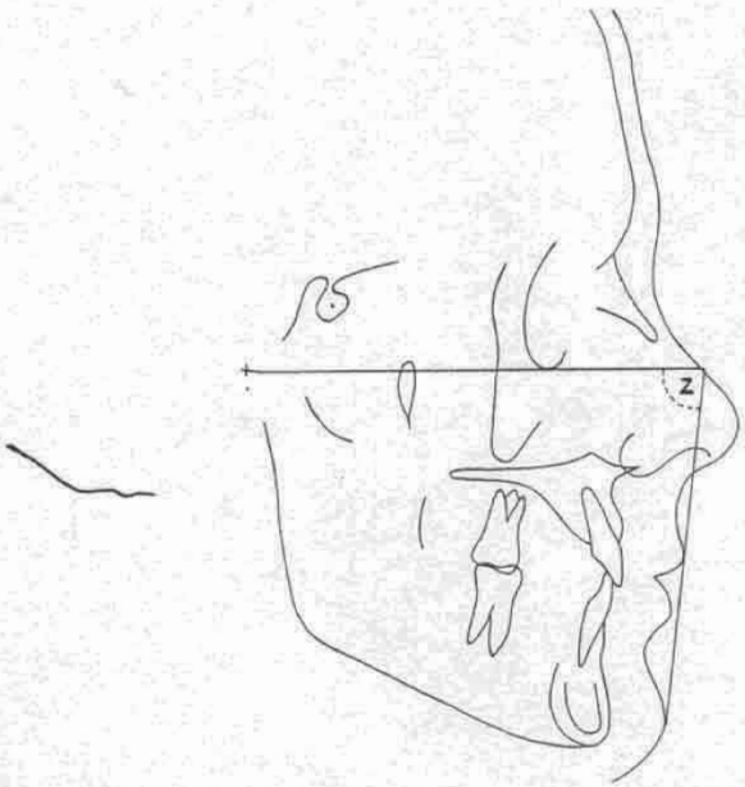

Fig. 5. Measurement used for the Z angle value.

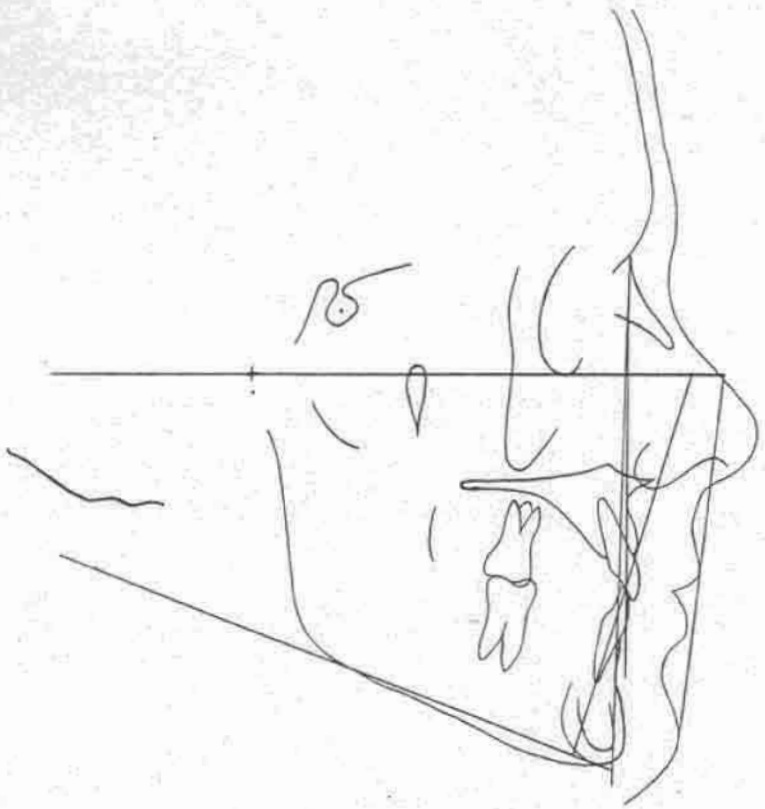

Fig. 6. A typical tracing showing all planes and angles used in this study.

the range for both total chin and upper lip thickness varied considerably, individually the samples routinely showed the chin measurement to be equal to or greater than the upper lip measurement.

The nonorthodontic normal group was predominantly female, there being only ten males in the group. To determine whether or not there were any significant sex differences, the same measurements were recorded for each sex (Table III).

Comparing the measurements of the males reported in this group with those of the females, we find that the males had an average Z angle of 82.2 degrees, while in the females the mean Z angle was 80.2 degrees. The males averaged 2.38 mm. greater thickness of total chin than of upper lip, whereas the females averaged 1.95 mm. greater thickness of total chin as compared to upper lip. These figures would indicate that the males had straighter profiles than the females.

In a further study, I selected ten samples from the group of forty which, in my opinion, showed outstanding harmony and balance of soft-tissue profile. Their measurements are recorded in Table IV.

The angles FMA, IMPA, and FMIA averaged essentially the same as in the larger group. However, the range was not as wide. The ANB angle averaged 1 degree less. The average Z angle was 80.2 degrees, 1.2 degrees less. The average of the total chin thickness dropped to 15.6 mm., 0.5 mm. less. The upper lip thickness increased a little more than 0.5 mm. to 14.4 mm. The range for all of

Table III. *Nonorthodontic normals*

Value	*Mean*	*Range*
Males		
FMA (degrees)	23.10	16 to 33
IMPA (degrees)	85.28	79 to 96
FMIA (degrees)	69.6	65 to 75
ANB (degrees)	2.33	0 to 5
Z angle (degrees)	82.2	71 to 86
Total chin (mm.)	16.78	13 to 20
Upper lip (mm.)	14.4	13 to 16
Females		
FMA (degrees)	23.57	14 to 34.5
IMPA (degrees)	87.14	80 to 95
FMIA (degrees)	69	64 to 80
ANB (degrees)	1.52	−2 to 18
Z angle (degrees)	80.2	73 to 89
Total chin (mm.)	15.65	12 to 18
Upper lip (mm.)	13.7	9 to 18

Table IV. *Ten best nonorthodontic normals*

Value	*Mean*	*Range*
FMA (degrees)	25.3	18.5 to 31
IMPA (degrees)	86.6	81 to 93.5
FMIA (degrees)	68.1	64 to 74
ANB (degrees)	0.95	−2 to 3
Z angle (degrees)	80.2	75 to 85
Total chin (mm.)	15.6	14 to 17
Upper lip (mm.)	14.4	13 to 16

these measurements narrowed. The reduction in the Z angle average can be attributed to the closer relationship of total chin thickness to upper lip thickness. In this group total chin thickness was approximately 1 mm. greater than upper lip thickness.

Individually, the profile line was, without exception, tangent to the upper lip. In eight of the ten samples the lower lip was also tangent; in two of the samples the lower lip was behind the profile line, but within 2 mm. of it.

The recorded measurements in the forty cases treated by Tweed and selected by him as representative of normal are shown in Table V.

This group of treated normal faces differed somewhat from the nontreated samples. The FMA and the IMPA angles were slightly higher, and the FMIA angles were slightly lower. The ANB angle was also higher, indicating slightly less balance in denture base relationship. The average Z angle measurement was 78 degrees, with a range from 68 to 88 degrees. The lip thickness and the total chin thickness were identical in this group—16.12 mm. of thickness for each. This equal relationship accounts for the reduction in the Z angle to a mean of

Table V. *Tweed orthodontic normals*

Value	*Mean*	*Range*
FMA (degrees)	25.6	15 to 36.5
IMPA (degrees)	87.5	72 to 100
FMIA (degrees)	66.9	58 to 81
ANB (degrees)	2.23	0 to 6.25
Z angle (degrees)	78	68 to 88
Total chin (mm.)	16.12	13 to 21
Upper lip (mm.)	16.12	12 to 23

Table VI. *Tweed orthodontic normals*

Value	*Mean*	*Range*
Males		
FMA (degrees)	27.9	15 to 36.5
IMPA (degrees)	85.6	75.5 to 93
FMIA (degrees)	66.41	58 to 80
ANB (degrees)	3.10	1 to 6.25
Z angle (degrees)	75	68 to 88
Total chin (mm.)	16.5	13 to 21
Upper lip (mm.)	18	15 to 23
Females		
FMA (degrees)	25.35	17 to 33.5
IMPA (degrees)	87.97	72 to 100
FMIA (degrees)	66.68	59 to 81
ANB (degrees)	2.09	0 to 5
Z angle (degrees)	78.7	73 to 87
Total chin (mm.)	16.28	13 to 19.5
Upper lip (mm.)	15.80	12 to 19

78 degrees. Individually, these samples also showed a close relationship of total chin thickness to upper lip thickness.

The nonorthodontic normals selected by Tweed were adults, whereas the orthodontic normals were studied at the completion of treatment several years before growth and maturation changes were complete. This could account for the 3.5 degree reduction in the Z angle and the equal thickness of total chin and upper lip. Further mandibular growth could add thickness to the total chin and change the relationship to the upper lip, but it is significant that at the end of treatment these measurements averaged the same and showed the same relationship individually.

In a separate study of the males and the females of this group, the data shown in Table VI were recorded.

Grouping the Tweed treated normals by sex and studying the data showed no significant difference in the FMA, FMIA, or IMPA angles. In the males of this group the average ANB angle was 1 degree greater. Considerable difference

was apparent in the soft-tissue study. The Z angle mean for females was 78.7 degrees, slightly higher than the mean for the entire group. The male Z angle averaged 75 degrees, almost 4 degrees less than for the females and 3 degrees less than the mean for the entire group of forty subjects. The male Z angle in this group averaged 7.2 degrees less than the same measurement for males in the nonorthodontic normal sample.

Another apparent difference in the two groups was the relationship of total chin to upper lip thickness. The female group had an average total chin measurement of 16.28 mm. and an average upper lip thickness of 15.80 mm., indicating slightly more total chin than upper lip thickness. The entire group of forty subjects showed an equal relationship of this measurement.

The males, in contrast, had a total chin thickness of 16.5 mm. and an average upper lip thickness of 18 mm. This, again, is at variance with the nonorthodontic normal male sample, as well as with the female portion of this group, but it does account for the lower average Z angle as compared to the other groups. This suggested that from the end of treatment to adulthood the males would have more growth and developmental changes, especially in total chin thickness, than the females. These findings coincide with the results of Subtelny's serial study.

A further selection of the ten faces which seemed most pleasing, judged solely on the basis of soft-tissue contour, balance, and pleasing esthetics, was made (Table VII).

This study of the ten most pleasing faces showed a decided narrowing of the range in all the measurements utilized. Comparing the ten best with the entire group of forty, the FMA and the IMPA mean measurements increased slightly less than 1 degree each, while the average FMIA measurement decreased 1.5 degrees. The ANB angle averaged slightly more. It was noted, however, that the average Z angle for the ten best samples remained at 78 degrees, the same as the average for the larger group of forty. The total chin thickness averaged 16.25 mm., slightly greater than the mean for the larger group. The upper lip thickness averaged 15.55 mm., 0.7 mm. less than the mean for the total chin and slightly less than the average for the entire group.

Comparing the mean Z angle of this group of ten treated normals with that of the ten untreated normals, we find that there was a 2 degree difference. This can be accounted for by the difference in relationship of total chin thickness to upper lip thickness; it is perhaps due to age differential.

Table VII. *Ten best Tweed orthodontic normals*

Value	*Mean*	*Range*
FMA (degrees)	26.4	20 to 31
IMPA (degrees)	88.25	80 to 95.5
FMIA (degrees)	65.35	60 to 73
ANB (degrees)	2.6	0 to 4.5
Z angle (degrees)	78.9	74.5 to 83.5
Total chin (mm.)	16.25	15 to 18
Upper lip (mm.)	15.55	13 to 18

Individually, only one face of the ten had a larger upper lip thickness than total chin thickness, and this one was only 0.5 mm. greater. Of the other nine faces, five had an equal relationship and four had a slightly larger total chin thickness. In the individual study of these ten good faces in the orthodontic sample, the profile line was tangent to the upper lip in every case; the lower lip was tangent in five samples and behind the line in five samples. In the latter five samples, the lower lip varied from 0.5 to 2 mm. behind the profile line.

The measurements secured from forty treated cases taken from my files are shown in Table VIII.

The forty treated samples from my files had a higher mean FMA angle (27.10 degrees). This was 1.5 degrees greater than in the forty Tweed-treated samples and almost 3 degrees greater than in the nonorthodontic normal sample. In the mandibular incisor inclination, average IMPA angle, this group was between the other two groups, with a mean of 87.2 degrees. All three groups were essentially the same, with a difference of less than one degree in the three groups of samples.

The average FMIA angle was 65.70 degrees, slightly lower than either of the Tweed sample averages, but this would be expected with the higher FMA angle. The slight difference in the mean ANB angle was not significant. All three groups were very close to the average normal of 2 degrees.

The Z angle for this group averaged 76.5 degrees, 1.5 degrees less than the Tweed-treated samples. This indicated that the Tweed-treated samples had slightly less convex faces. The total chin thickness averaged 16.40 mm., and the upper lip thickness averaged slightly more (16.50 mm.). This would indicate a smaller average Z angle, since the Tweed-treated samples had the same average thickness for the two measurements.

Table IX shows the data recorded in a separate study of the males and the females of this group of forty.

The average measurements for angles FMA, IMPA, and FMIA were similar. The ANB angle in each group averaged within 0.5 degree; the female ANB angle averaged 2.4 degrees, and the male ANB angle averaged 2 degrees.

The significant difference between the males and females was most apparent in the soft-tissue analysis. The Z angle averaged 75.3 degrees in the males and 77.7 degrees in the females. The total chin thickness of the males averaged 16.4 mm., compared to an upper lip thickness of 18.6 mm., quite different from the

Table VIII. *Merrifield treated normals*

Value	*Mean*	*Range*
FMA (degrees)	27.10	17.5 to 40
IMPA (degrees)	87.20	77.5 to 97
FMIA (degrees)	65.70	58 to 75
ANB (degrees)	2.08	−0.5 to 6.5
Z angle (degrees)	76.50	72 to 85
Total chin (mm.)	16.40	13 to 21
Upper lip (mm.)	16.50	12 to 23

two measurements in the female group, which had an average total chin thickness of 16.27 mm. and an upper lip thickness of only 15.31 mm. This was the reason for the larger average Z angle in the females.

Individually, the female samples also had a total chin thickness that was routinely equal to or slightly greater than the upper lip thickness. The reverse was true in the male sample; the upper lip was slightly thicker than the total chin in almost all of the males.

Following the same procedure as in the other groups, ten samples representing the best in facial harmony were selected from the group of forty from my files. The findings are shown in Table X.

The average FMA, IMPA, FMIA, and ANB angles did not change significantly as compared to the larger group; however, the range for each of these angles became more narrow.

The Z angle mean did increase, as compared to the group of forty, from

Table IX. *Merrifield orthodontic normals*

Value	*Mean*	*Range*
Males		
FMA (degrees)	26.6	18 to 40
IMPA (degrees)	86.7	81 to 94
FMIA (degrees)	66.7	59 to 73
ANB (degrees)	2	−0.5 to 3.5
Z angle (degrees)	75.3	72 to 83
Total chin (mm.)	16.4	13 to 21
Upper lip (mm.)	18.6	15 to 23
Females		
FMA (degrees)	27.36	17.5 to 39
IMPA (degrees)	87.36	77.5 to 97
FMIA (degrees)	65.28	58 to 75
ANB (degrees)	2.4	0 to 6.5
Z angle (degrees)	77.70	72.5 to 85
Total chin (mm.)	16.27	13 to 20
Upper lip (mm.)	15.31	12 to 19

Table X. *Ten best Merrifield orthodontic normals*

Value	*Mean*	*Range*
FMA (degrees)	26.65	21 to 34
IMPA (degrees)	87.50	80 to 94
FMIA (degrees)	65.85	59 to 74
ANB (degrees)	2.4	0 to 5.5
Z angle (degrees)	78.65	73 to 83
Total chin (mm.)	16.2	14 to 20
Upper lip (mm.)	14.5	12 to 16

76.5 degrees to 78.65 degrees. Here the range also was less. The total chin thickness had an average measurement of 16.2 mm., while the upper lip thickness averaged only 14.5 mm.

Individually, these ten samples all had as much total chin thickness as upper lip thickness, or more. In studying the relationship of the lower lip to the profile line, we find that in one sample the lower lip was tangent to the profile line, with the upper lip 0.5 mm. behind the line. In nine samples the profile line was tangent to the upper lip, and in six of these nine the lower lip was also tangent to the profile line. In three of the nine samples the lower lip was behind the line, but none measured more than 2 mm. behind the profile line.

DISCUSSION

The area of the face on which the clinical orthodontist focuses his attention are the soft tissues in the lower facial region contiguous to the underlying areas where orthodontic intervention has influence. In this study, the data were used to evaluate critically the mouth profile and chin relationship.

The results of this study indicate that total chin thickness is of prime importance in profile evaluation. Either bony chin or soft-tissue chin may be in ill proportion, but so long as one compensates for the other profile balance will not suffer.

The use of a line tangent to soft-tissue pogonion and to the most anterior point of either the lower or the upper lip as a profile line may not be as good as using the upper lip at all times and relating the lower lip to the line, as Holdaway does. In cases of malocclusion, however, it does give the full extent of the lip protrusion when expressed as an angular measurement (Z angle).

In the ten most pleasing samples taken from each of the three groups, twenty-nine samples showed the upper lip tangent to the profile line and one sample showed the upper lip 0.5 mm. behind the profile line. Nineteen of the thirty also had the lower lip tangent to the profile line. Ten samples showed the lower lip behind the line, but never more than 2 mm.

The sex differences noted in this study were rather clear cut. Each group helped substantiate the other, but it should be pointed out that the male samples were very small, there being only 26 males in the 120 samples studied. This limits the reliability of these findings.

In the nonorthodontic normals, most of whom were adults, the males had higher average Z angle measurements than the females. In the two groups of treated normals, all of whom were young boys and girls, the females had higher average Z angle measurements. This coincides with other studies indicating that females reach maturity faster and show less change after orthodontic treatment.

In the females, individually and collectively, in the orthodontic groups total chin thickness was equal to or greater than upper lip thickness. The males showed a greater variation in this relationship and, on the average, exhibited greater upper lip thickness than total chin thickness. The reverse was true in the older nonorthodontic group. It was also noted in the ten best faces selected from each of the three groups that the thirty samples included only two males and

twenty-eight females. One of the males was in the nonorthodontic normal group and one was from the group from my files. This suggests that our critical concept of facial balance and harmony is more readily achieved in the female.

The Z angle formed by the intersection of the profile line and Frankfort plane gave an angular relationship of the lower face. The study indicated that an angular measurement of 80 degrees with a range of plus or minus 5 degrees could be considered in evaluating the adult face.

The angular measurement of 78 degrees with a range of plus or minus 5 degrees should be very useful to the inexperienced clinician in his efforts to achieve maximum facial esthetics.

The soft-tissue data indicated that there could be a wide range of facial convexity in samples in which measurements of the three angles of the diagnostic triangle were similar.

Vertical facial relationship would alter the over-all facial balance of individuals within the normal Z angle range. The Frankfort plane was used in establishing the Z angle because it can be visualized in the patient, in the photograph, and in the lateral head roentgenogram.

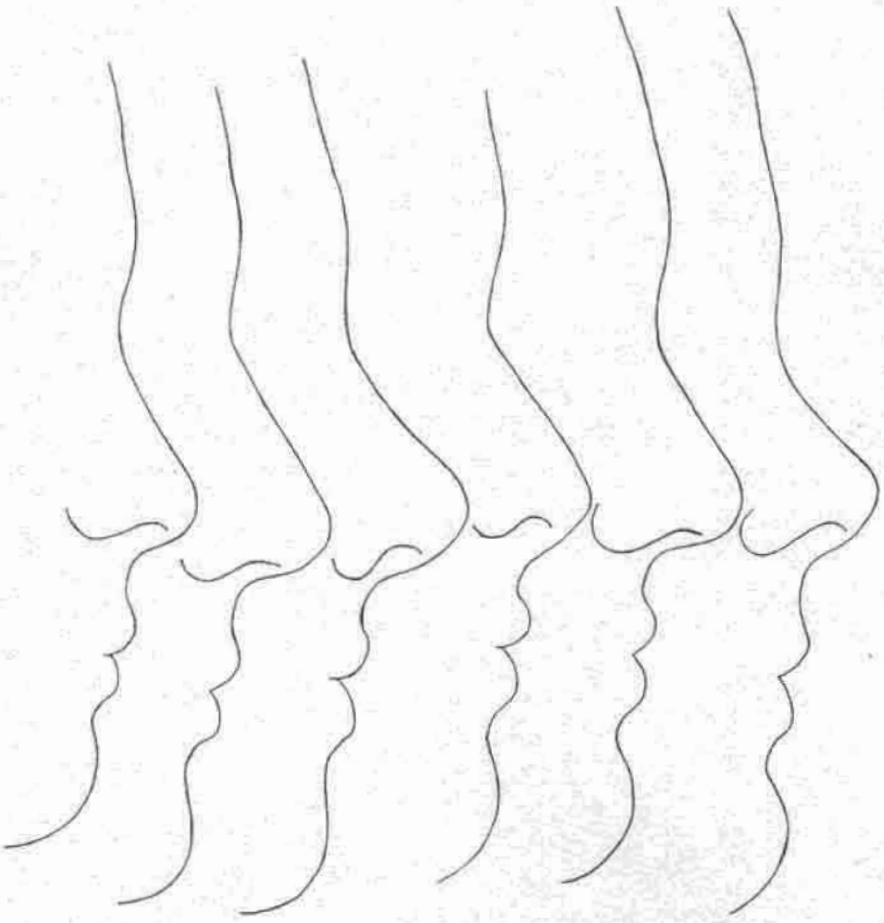

Fig. 7. Facial outline of samples used in this study which show the Z angle range from, left to right, of 74 degrees, 76 degrees, 78 degrees, 80 degrees, 82 degrees, and 84 degrees. (All outlines oriented on Frankfort plane.)

The findings from this study coincide, within narrow limits, with the findings of Tweed with respect to the angular measurements FMA, FMIA, and IMPA.

Fig. 7 shows the facial outlines of samples used in this study that illustrate the facial convexity with varying Z angle measurements.

SUMMARY

1. The proportion of the lower face can be defined within a narrow range.
2. The Z angle measurement and the profile line give a critical description of lower face relationship and eliminate the vagueness of "eye judgment."
3. The total chin thickness should be equal to or slightly greater than the upper lip thickness.
4. The lip relation can be judged accurately by relating it to the profile line. The upper lip should be tangent to the line; the lower lip should be tangent or slightly behind the profile line.
5. With normal FMA, IMPA, FMIA, and ANB measurements in the adult, the normal Z angle is 80 degrees.
6. With normal FMA, IMPA, FMIA, and ANB measurements in patients 11 to 15 years of age, the normal Z angle is 78 degrees.
7. The young female patient, at the completion of orthodontic treatment, has a better chin-lip relationship than does the young male patient at the same time.

REFERENCES

1. Alessandra, P.: The Integumental Profile and Its Supporting Dento-skeletal Framework, Master of Science Thesis, University of Texas, 1959.
2. Angle, E. H.: Malocclusion of the Teeth, ed. 7, Philadelphia, 1907, S. S. White Dental Mfg. Co.
3. Barnett, J. W.: The Integumental Profile and Its Supporting Dento-skeletal Framework, Master of Science Thesis, University of Texas, 1959.
4. Baum, A. T.: Age and Sex Differences in the Dentofacial Changes Following Orthodontic Treatment and Their Significance in Treatment Planning, AM. J. ORTHODONTICS 47: 355-369, 1961.
5. Bloom, L.: Perioral Profile Changes in Orthodontic Treatment, AM. J. ORTHODONTICS 47: 371-379, 1961.
6. Bowker, W., and Meredith, H. V.: A Metric Analysis of Facial Profile, Angle Orthodontist 29: 149-160, 1959.
7. Burstone, C. J.: The Integumental Profile, AM. J ORTHODONTICS 44: 1-25, 1958.
8. Burstone, C. J.: Integumental Contour and Extension Patterns, Angle Orthodontist 29: 93-104, 1959.
9. Downs, W. B.: Variations in Facial Relationships: Their Significance in Treatment and Prognosis, AM. J. ORTHODONTICS 34: 812-840, 1948.
10. Downs, W. B.: Analysis of the Dentofacial Profile, Angle Orthodontist 26: 191-211, 1956.
11. Holdaway, R. H.: Changes in Relationship of Points A and B During Orthodontic Treatment, AM. J. ORTHODONTICS 42: 176-193, 1956.
12. Holdaway, R. H.: Personal Communications; Unpublished Material on Relationship of Lower 1 to NB and PO to NB, 1957.
13. Holdaway, R. H.: Personal Communications; Unpublished Material on A Consideration of the Soft Tissue Profile for Diagnosis and Treatment Planning, 1958.
14. Moore, A. W.: Observations on Facial Growth and Its Clinical Significance, AM. J. ORTHODONTICS 45: 399-423, 1959.

15. Neger, M.: A Quantitative Method for the Evaluation of the Soft Tissue Facial Profile, AM. J. ORTHODONTICS 45: 738-751, 1959.
16. Ricketts, R. M.: A Foundation for Cephalometric Communication, AM. J. ORTHODONTICS 46: 330-357, 1960.
17. Ricketts, R. M.: Cephalometric Synthesis, AM. J. ORTHODONTICS 46: 647-673, 1960.
18. Riedel, R. A.: An Analysis of Dentofacial Relationships, AM. J. ORTHODONTICS 43: 103-119, 1957.
19. Salzmann, J. A.: The Research Workshop on Cephalometrics, AM. J. ORTHODONTICS 46: 834-847, 1960.
20. Schwarz, M. A.: Roentgenostatics—A Practical Evaluation of the X-ray Headplate, AM. J. ORTHODONTICS 47: 561-585, 1961.
21. Steiner, C. C.: Cephalometrics for You and Me, AM. J. ORTHODONTICS 39: 729-755, 1953.
22. Steiner, C. C.: The Use of Cephalometrics as an Aid to Planning and Assessing Orthodontic Treatment, AM. J. ORTHODONTICS 46: 721-735, 1960.
23. Stoner, M. M., and Lindquist, J. T.: A Cephalometric Evaluation of Fifty-seven Consecutive Cases Treated by Dr. Charles H. Tweed, Angle Orthodontist 26: 68-98, 1956.
24. Subtelny, J. D.: A Longitudinal Study of Soft Tissue Facial Structures and Their Profile Characteristics, Defined in Relation to Underlying Skeletal Structures, AM. J. ORTHODONTICS 45: 481-507, 1959.
25. Subtelny, J. D.: The Soft Tissue Profile, Growth and Treatment Changes, Angle Orthodontist 31: 105-122, 1961.
26. Tweed, C. H.: Indications for the Extraction of Teeth in Orthodontic Procedure, AM. J. ORTHODONTICS 30: 405-428, 1944.
27. Tweed, C. H.: A Philosophy of Orthodontic Treatment, AM. J. ORTHODONTICS 31: 74-103, 1945.
28. Tweed, C. H.: Why I Extract Teeth in the Treatment of Certain Types of Malocclusion, Alpha Omegan 46: 93-104, 1952.
29. Tweed, C. H.: Evolutionary Trends in Orthodontics, Past, Present, and Future, AM. J. ORTHODONTICS 39: 81-108, 1953.
30. Tweed, C. H.: The Frankfort-Mandibular Incisor Angle (FMIA) in Orthodontic Diagnosis, Treatment Planning and Prognosis, Angle Orthodontist 24: 121-169, 1954.
31. Wylie, W. L.: The Philosophy of Orthodontic Diagnosis, AM. J. ORTHODONTICS 45: 641-654, 1959.
32. Wylie, W. L.: Discussion of the Lower Incisor; Its Influence on Treatment and Esthetics, AM. J. ORTHODONTICS 45: 50-54, 1959.

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